City of Chefornak

Design Analysis Report

Chefornak Pump House 1

Chefornak, Alaska

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FINAL

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Contents

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I. Executive Summary

The Design Analysis Report (DAR) for the proposed Pump House 1 project is the first of four steps in the design of this facility. The proposed Pump House 1 at Chefornak is being designed to replace the existing Water Treatment Plant that was constructed by the Public Health Service in 1985. This existing facility has seriously deteriorated in almost 30 years of service and now has the following major deficiencies:

- The existing foundation, consisting of 6-in steel pipe piles and 6-in W stringer beams has been settling at the east end of the building, and the steel elements of this foundation have been severely rusted and eroded, due to the marine environment.
- The sandwich foam floor panels on the floor have been rotting on the wood outer layers, and the interior urethane foam insulation is completely water soaked.
- The existing 4,000 gallon welded steel water tank has had its interior coating fail, and well water started contacting the steel wall and tank bottom, necessitating the installation of a PVC tank liner to extend the life of the tank.
- Internal equipment and piping is showing its age, and coupled with the structural deficiencies in the building shell and foundation, makes a major remodel impractical.

This project was the second priority of improvements to the Chefornak Water and Sewer System.

The proposed Pump House 1 will be a 24-ft wide x 28-ft long x 8-ft high sidewalls, placed atop a 6-in steel micropile foundation. Plan View and Elevations of the proposed facility are shown on Sheets A1.0 and A2.0 of the 35% Plan Set (Appendix A). The proposed building size gives adequate room for equipment, maintenance, and storage of supplies and tools for operation of the facility and the watering points. Varying the building shell size will produce only minor changes in cost of the facility.

The building will contain two each 2,500-gallon HDPE water storage tanks, cartridge filters and well controls. It will also contain a pressure pump system, water distribution loop circulation system, and a building and water distribution backup heat exchanger and controls, used if the waste heat recovery system at the City Power Plant is not available for any reason.

Geotechnical considerations necessitated a steel pipe micropile-type foundation, due to the widely varying areas of frozen and thawed subsoil that prevented the use of a passively cooled gravel fill foundation and Triodetic foundation space frame. Fortunately, the building site has an ancient lava flow underlying the soil at a depth of

30 feet that has supported a number of structures in the area using piles driven or drilled to this bedrock layer.

A tentative construction schedule is envisioned as follows:

- The plans should be completed in the first two weeks of January 2015.
- Fire Marshal approval should be obtained at the end of January 2015.
- Request for bids for foundation piles will be issued in Mid January 2015.
- A temporary water and heating system would be constructed in February 2015 in the existing pump house.
- Demolition of half of the existing pump house building would be performed in March, 2015 to allow room for the new micropile grid to be constructed.
- The micropile foundation grid would be installed March-April 2015 while the ground surface is still frozen. This operation would be performed in conjunction with the Washeteria/Water Tank, and Pump House 2 micropile foundation projects to minimize mobilization and demobilization costs for each project by combining them to one overall project.
- Request for bids will be issued in early March 2015 for the June barge 2015.
- The building shell and internals would be constructed in Summer and Fall 2015 as soon as materials arrive on the first barge to Chefornak.

Capital costs for Pump House 1 improvements are estimated at **$893,718**. Details of the capital cost estimate are found in Section VI Cost Estimates of this DAR.

Annual operating costs for Pump House 1 improvements are estimated at **$34,685 per year**. Details of the operating cost estimate are found in Section VI Cost Estimates of this DAR.

II. Introduction/Purpose/Background

The proposed Pump House 1 in Chefornak is being designed to replace the existing Pump House that was constructed in 1985. The existing Pump House has experienced floor rotting and major settlement in its pile foundation under the existing steel water storage tank when it was located at the east end of the building. The new facility will be much more energy efficient for heating and pumping of water. It will also have piping, pumps, and heat exchangers that will better address the existing needs of the water delivery system in Chefornak.

The proposed Pump House 1 will be 24 ft wide x 28 ft long x 8 ft high at the end walls. It will have a gable roof with a 4:12 pitch. Engineered wood floor joists and rafters will be used for floor and roof, respectively. Floor and ridge beams with be glued-laminated beams. Walls will be structural insulated panels (SIP).The foundation will be 6 in pipe micropiles.

Plan view and elevations of the proposed facility are seen in Plan Sheets A1.0 and A2.0 of the 35% plan set in Appendix A.

A. Location

The site is situated in the northeast corner of the built-up community, immediately west of the Alaska National Guard Armory. The site for the proposed Pump House 1 replacement of the existing WTP is located on Lot 7, Block 2, Tract A, USS 4421. It is presently used for the existing WTP. A copy of the original Trustee Deed, as well as the Bethel Recorder’s Office Document Display of information pertaining to this Deed is found in Appendix B.

B. Existing Site Conditions

The existing site is on a relatively flat area, covered in local grasses, with some standing water on about one-third of the ground. The original 6-in steel pipe piling in heavily loaded areas of the east end of the existing WTP have settled down at least 3 inches, while the west half of the WTP has not had significant settling. This could indicate thawing of the frozen ground since the WTP was constructed. It could also indicate that some piles were founded on float boulders, embedded in an ice-rich soil that thawed and settled the boulders, rather than most piles sitting on top of the submerged lava flow bedrock.

C. Existing Facilities

The existing WTP facility is a panelized building, used all over rural Alaska by the US Public Health Service during the 1970s and 1980s. The dimensions of the main building are 20-ft wide x 36-ft long x 10-ft high side walls. The building sits atop 6-in steel pipe panels and 6-in deep steel wide flange beams. The building insulated wall panels are framed 2x6 lumber, with T1-11 siding on the outside and ¾-in thick plywood on the inside, with a urethane foam core. Roof and floor insulated panels use 2x8 lumber and ¾-in plywood for the inside and outside skins, sandwiching frothed in place urethane insulating foam.

The existing WTP contains:

- A 20-ft long insulated arctic pipe well line from the well water source to the building;
- A 4,000 gallon vertical steel water storage tank
- An old and unusable liquid water treatment coagulant injection system;
- Two 12-in fiberglass tank multimedia filtration systems with automatic controls inoperative and no coagulation used at this time;
- A pressurization pump system consisting of shallow well pumps and hydropneumatic tanks;
- Canned rotor cast iron circulating pumps for the water distribution system;
- Hydronic heating system for building, water tank, and water distribution system in poor condition;
- Surface mounted 120/240 single phase electrical and lighting system.

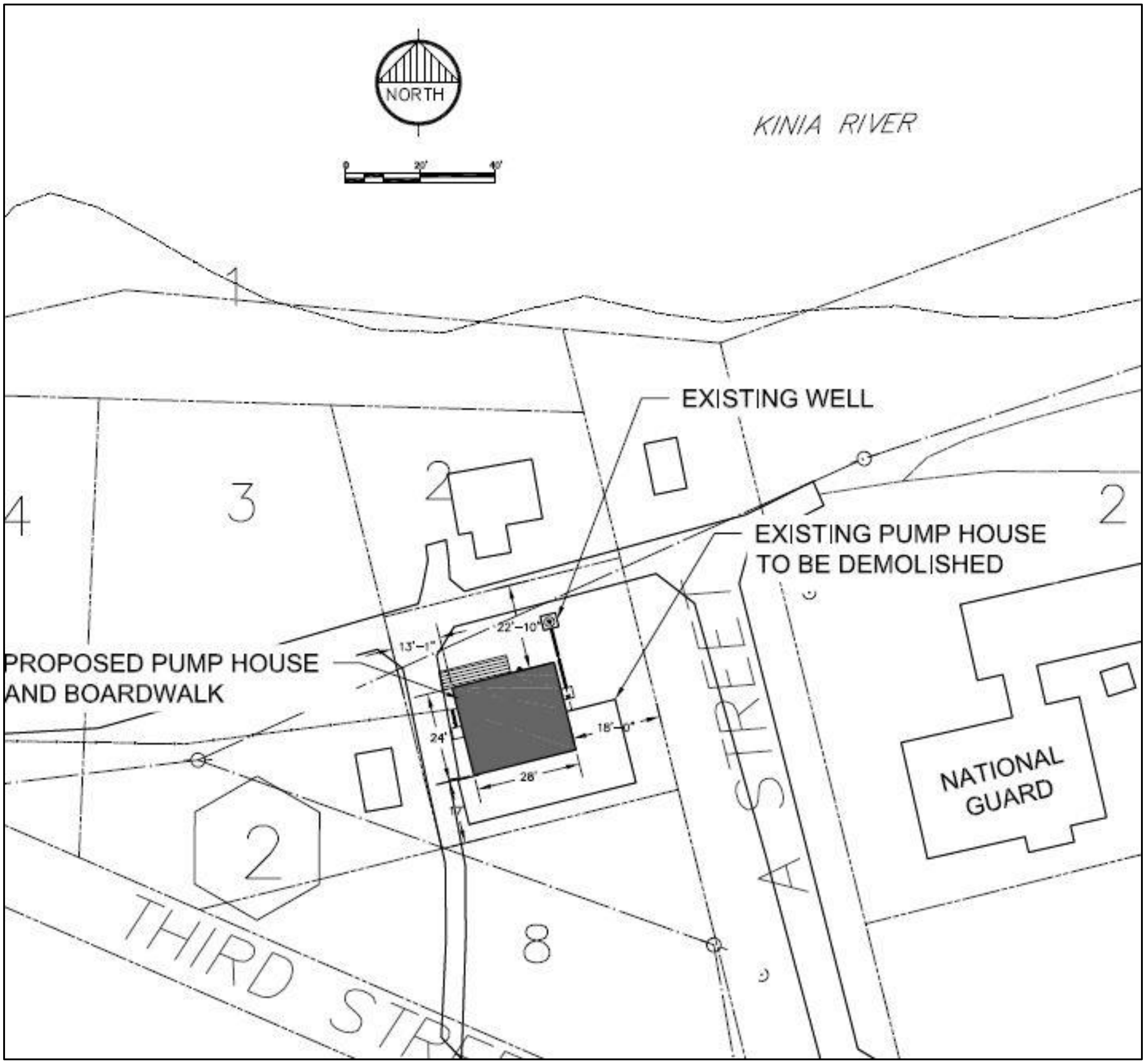
D. Water Source

The present water source is a well drilled by the US Public Health Service in 1964 in the northeast corner of the community near the PHS Pump House. This water has a total dissolved solids TDS of approximately 1000 mg/liter at this time. The other main component of the water is color, which was seen to be in the vicinity of 80 PCU. As this is used for utility water for washing clothes, saunas, household cleaning, handwashing, and showering, this water is not presently treated, with the exception of filtration with a multimedia filter without using coagulant. Total dissolved solids (TDS) has varied from 541 to 606 mg/l, depending upon the pumping rate. Iron varies between 0.22 to 0.8 mg/l. Water quality data for the existing well serving this pump house is found in Appendix C.

E. Site Plan

The location of the proposed Pump House 1 is shown below in Figure 1. It is located on Lot 7, Block 2, Tract A, USS 4421. This new pump house will replace the existing structure on the same lot. Because of extreme site constraints—the small lot size and geotechnical issues—the new facility pile foundation will have to be drilled in spring before the thaw. This will necessitate that half of the old facility be demolished to accommodate drilling piles for the new facility. The remaining half of the facility will serve as a temporary pump house until the new facility is on line. A temporary operating plan and demolition plan for the existing pump house will be part of the plan set and will show up in the 65% level plans. The full site plan is shown in sheet C2 of the 35% Plan Set presented in Appendix A.

Figure 1—Proposed Location: Pump House 1



All nearby lots were examined for possible use as sites for Pump House 1. However, Lots 2, 3, and 8 in Block 2 above are Native restricted deed lots, so that transfer to the City would be complicated, possibly taking years, and could cost significant money to buy from the present owners. We cannot build in the right of way, so reusing the existing City-owned lot was the best alternative for the new pump house.

III. Design Requirements and Considerations

A. Population/Design Life

Based upon US Census Data for Census Years 1990, 2000, and 2010, and 2012 population estimate, population is shown in tabular form:

Year	Population	Difference	Annual Pct Increase Equivalent
1990	320	-	-
2000	394	79	2.1%
2010	418	24	0.6%
2012	434	16	0.4%
2034 (projected)	*458*	*24*	*0.5% (assumed)*

As seen from the above figures, the population growth rate has been steadily dropping in the last 30 years. A conservative estimate for an annual growth rate in the next 20 years (assuming a design life of 20 years) is 0.5%. With this in mind, the 20 year design horizon population figure is estimated at 458.

B. Soil Conditions

Chefornak is located on the south bank of the Kinia River, about 6 miles east of Etolin Strait. It lies near the present coastal margin of the Yukon-Kuskokwim Delta, which is comprised of thick unconsolidated alluvial, deltaic, and aeolian deposits of silts and fine sands, with some gravelly sands. Sediments in this area are at least 230 ft thick. Basaltic flows from Tern Mountain, about 5.5 miles to the south, extend northward to beneath the City of Chefornak. The City well drilled in Chefornak lies on a recent volcanic sequence within about 25 to 30 feet of the surface. This lava flow is 25 to 39 ft thick. Soil conditions around the existing City pump house consist of about 1 ft of organics, followed by about 12 ft of areas of frozen or thawed silt, fractured basalt, and hard basalt.

C. Regulatory Requirements

- Applicable Codes: Title 13 of the Alaska Administrative Code, Chapters 50 through 55, was adopted and amended to the 2009 International Building, Fire, and Mechanical Codes, as adopted and amended by the State of Alaska.
- Design Minimum Temperature: -50°F
- Design Degree-Days for heating to 65°F: 13,200 °F*Days / year

- Design Degree-Days for heating to 50°F: 7,900 °F*Days / year
- Design ground snow load: 40 lb/sf. Note that snow drifting is a significant factor in Chefornak. The structural engineer must take drifting into account during design.
- Maximum Wind, 3-second gust: 130 MPH, Exposure C.
- Seismic Design: Site Class D, Spectral response acceleration at short period--- S_{DS} = 0.15, for long period--- S_{D1} = 0.07

D. Pump House 1 Design Criteria

1. Geotechnical Considerations

Soil sampling was performed for the site of Pump House 1 on August 20-21, 2014, by Golder and Associates (Golder). A Hilti impact hammer was used to sample soils down to about the 6 ft level. Geotechnical findings indicate a seasonal thawed layer from the surface to 3 ft below the surface. Below that is a frozen layer for a distance of 10 ft north of the north side of the existing PHS-constructed Pump House. Beyond 10 ft north, the soil is completely thawed as far as could be reached with the Hilti.

Golder's recommendation is to use a 6-in pipe micropile, end bearing, in bedrock (ancient lava flow), for a foundation. There are now portable drill rigs that can be flown in with small air freighters into Chefornak. This work can be done in spring before thaw, so a foundation would be ready for building construction when the first barge comes to Chefornak in June.

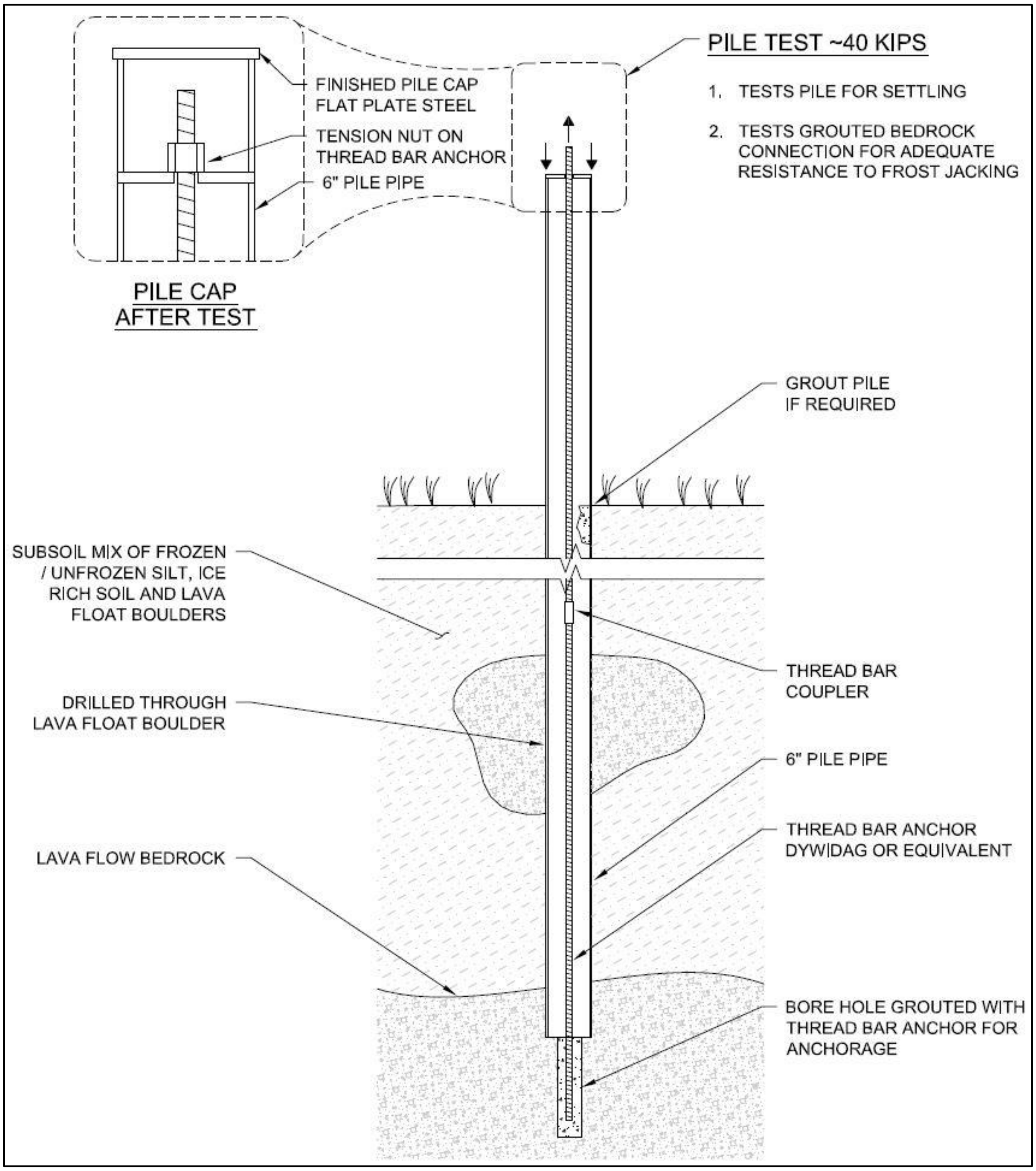
Piles in normal use in Chefornak are pipes specially fabricated for being set in drilled holes in the permafrost, backfilled with a sand slurry, and frozen in the ground, where they get their strength. They are expensive and require large installation equipment (Cranes and drill rigs) that have to be brought in by barge in the summer or fall and left on site until the next summer. Micropiles are usually nor more than 6 inches in diameter and do not incur the very high mobilization and demobilization costs required of large piles.

The foundation design is to drive the piling down to an obstruction (lava boulder floating in matrix of silt and ash), then the obstruction is drilled about 2 ft. If soil is encountered after going through the obstruction, then the pile is continued until bedrock, where further drilling of about 1.5 ft depth is done to seat the pile. See **Error! Reference source not found.**2 (next page) for a section of a typical micropile, as envisioned for Chefornak.

A geotechnical report from Golder Associates is presented in Appendix D.

General loadings on piles will range from 7 to 14 kips. Uplift from frost heave will require that these micropiles be rated for uplift in excess of the static loading, due to 40 psi ice adhesion along the pile perimeter through the expected active layer for frost uplift. This ice adhesion translates to almost 10,000 lb per foot of 6-in pipe. It will be necessary to have a tension bar grouted into the bedrock at each pile to resist this frost uplift in the soil active layer.

Figure 2—Typical Foundation Micropile



2. Building shell and foundation structural design

a. Building Form

The building will be a one story rectangular structure, 24-ft wide x 28-ft long, with a gross area of 672 sq ft. with an open ceiling. The roof will consist of a ridge beam and columns embedded in structural insulated wall panels (SIP), supporting engineered wood beam rafters with a clear span between the ridge and the exterior side walls. The ends of the roof beams will be configured in gable fashion.

The floor will be standard wood joist construction (BCI or LVL type joists) sitting on glu-lam beams, which in turn are supported on a 6-in micropile pipe foundation.

Partition walls will be non-structural and will be 2x4, or 2x6 framing, as required.

Building outside walls will be 8 in thick SIP panels, and the roof will be constructed of engineered joists (BCI's) with treated OSB or plywood sheathing.

Wind will be the governing factor in designing the structure to resist lateral forces and the resulting overturning moment on Pump House 1 when the two 2500-gallon water tanks are empty (worst case).

b. Exterior and Interior Materials

Exterior materials for the roof and walls will be treated OSB or plywood, sheathed with metal roofing and siding. The soffit on the underside of the floor will be plywood. The area under the foundation will be secured with chain link or similar open mesh fencing to prevent unauthorized entry under the building.

Interior materials will be OSB or plywood on the walls and ceiling, with vapor barrier and 5/8" gypsum wall board bonded to white FRP panels on the surface for cleanliness. Structural subfloor will be 3/4" thick plywood covered with 3/8" thick underlayment and an epoxy floor.

c. Snow Drifting Considerations

The major area of snow drifting occurs on the west side of structures. Consequently, the entrance to the building should be on the north side, and structures like fuel tanks, well heads, and the proposed Pump House should be approximately 4 ft off the ground to allow for wind currents to move snow under them to avoid snow drifting.

3. Internal Water Storage Tank

a. Design Criteria

The following design criteria govern the parameters of the City well pump and Pump House 1 water storage tank:

- Continuous water demand is greatest when the school is pumping water continuously to feed its UF/RO process, about 7 gpm, or about 2500 to 3,000 gallons per day. The school treatment system operates 2 to 3 times per day, and operates automatically. Most of this demand will be handled by the 22,000 gal storage tank at the future Washeteria. The 22,000 gallon tank can provide almost a week of reserve water to serve the school in an emergency.
- Pumping well water from the existing PHS well is limited by experience to 15 gallons per minute (gpm). For a 10 gpm demand, the well pump will have a duty cycle of 0.67. However, the design goal is to minimize the level of total dissolved solids (TDS) in the pumping of water from the city well. To accomplish this goal, the closer the well is pumped to the average daily flow rate, the lower the TDS will be relative to higher pumping rates with higher well draw downs (with possible up-coning of higher saline water below the well pump. Varying the speed of the well pump with the level of the water tank should be designed into the system with a variable speed drive (VFD) for the submersible well pump.
- Water storage in Pump House 1 should be 5000 gallons, as this will allow about 6 hours continuous demand at 10 gpm without running the well pump, and would leave over 1,300 gallons of reserve for watering points, the clinic, and Washeteria demand, if the pump needed maintenance or replacement.
- A portable TDS meter should be available for the operator to spot test the well water going into the tank.
- Tankage should be 2 ea 2500 gallon HDPE vertical upright tanks, approximately 8 ft dia x 7.5 ft high, NSF 61 listed, and a floor pressure not to exceed 500 lb/sf on the floor of Pump House 1.
- There must be two ports: one for drawing water out of the tank (tank suction), and another for filling the tank on the top of the tank. An air gap should be provided above the top of the tank with a standpipe extended down to the bottom of the tank interior to minimize splashing and disturbing of the water surface, as well as to separate the tank from the well line and well. This will maximize accuracy of the ultrasonic or radar tank level sensing unit.

b. Foundation

The tanks will sit on the finished floor of Pump House 1 atop an epoxy coated finished floor. A one inch thick layer of Armaflex, Rubatex, or other closed cell elastomer insulation should be installed on the tanks to prevent moisture condensation on the sidewalls of the tanks. The loads on the floor area supporting the water storage tanks will be micropiles, as determined by the Structural Engineer. Structural sheet S1.1 shows the micropile layout in foundation detail 1.

4. Building shell thermal design

The thermal envelope of the Washeteria is designed to provide exceptionally low heat loss. The walls will be 8-inch rigid Styrofoam in SIP panels, so the insulation value of the walls will approximately be R-30. The roof will consist of 14 in deep BCI type rafters and 12 in of fiberglass insulation for an approximate R-40 insulation value. The floor would be BCI type joist construction with 12 in of fiberglass insulation for an approximate R-40 insulation value.

5. Water Treatment

Water used for the past thirty years in Chefornak from the existing PHS well has had minimal treatment, mainly consisting of filtration with multimedia filters, generally without coagulant, and chlorination. The water produced is not used for drinking, due to higher levels of total dissolved solids (TDS) up to 1000 mg/liter. This water is instead considered “utility” water for hand washing, bathing, steam baths, and laundry. Traditionally, drinking water has come from collected rain water, small streams or springs, and ice harvested in winter from local lakes.

Basically, we have three alternatives for water treatment at Pump House 1:

- Alternative 1: No treatment but straight through piping from the well to the water tanks.
- Alternative 2: Multimedia filtration with coagulation.
- Alternative 3: Cartridge filtration.

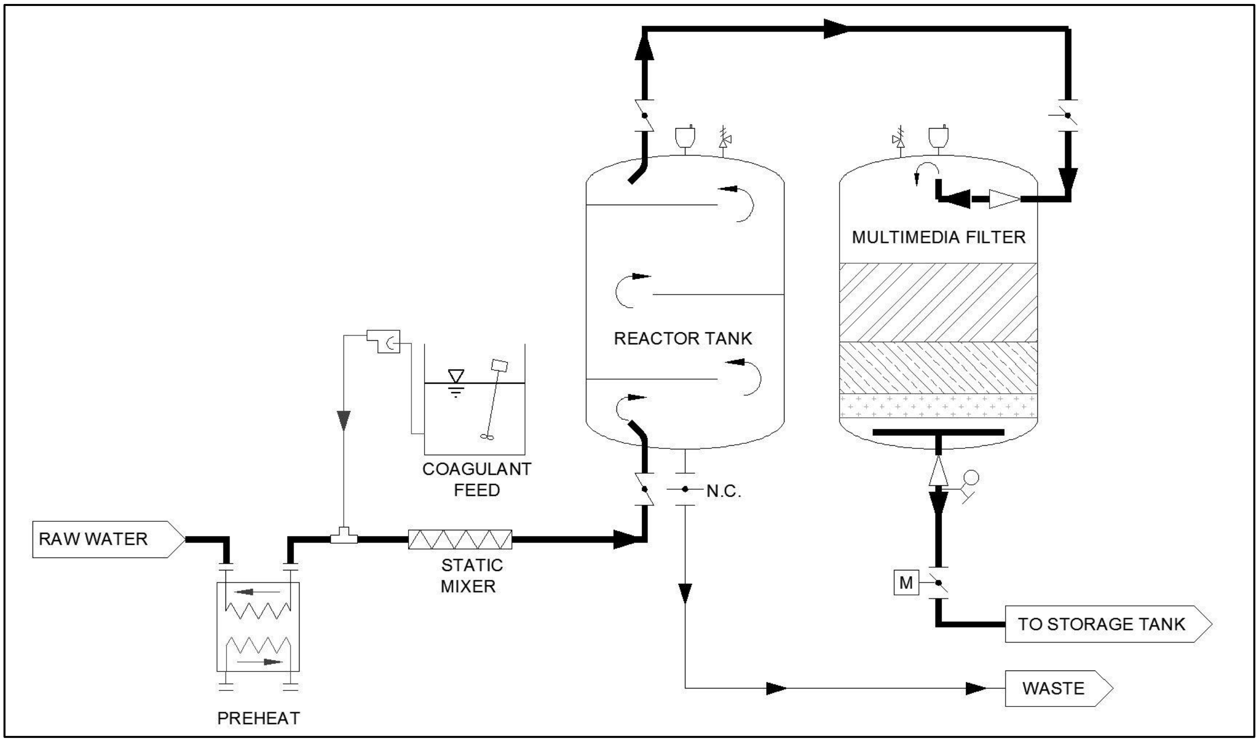
Treatment Alternative 1 should be used if treatment costs are to be minimized.

Treatment Alternative 2 is similar to what the treatment plant has now, but presently without a reactor tank to provide time for the buildup of floc before multimedia filtration occurs in the next vessel, as shown on the next page in Figure 3.

Advantages: Produces more aesthetically pleasing water, a slightly better product for utility use: bathing, hand washing, clothes washing. Also saves on the cost of cartridge filters in Treatment Alternative 2.

Disadvantages: Capital costs for multimedia filtration are about $40,000 higher than cartridge filter systems. To optimize the system, raw water to be filtered must be heated from 35°F well water to 50°F before filtration to make the process work, which adds an additional $2.79 per hour of oil for water preheat, or $0.01 per gallon to the price of water to cover heating cost. Operator knowledge of the multimedia process is most important to have the system work, or the system will fail to filter the raw water. Annual cost of coagulant chemicals are estimated at $2000, and additional oil for preheat will be about $10,000 to $16,000.

Figure 3—Multimedia filtration process flow diagram



Treatment Alternative 3: A simplified filtration system would consist of two stainless filter housings in series: the first one containing a 10-micron pleated filter, and the second one containing a 5-micron filter. This simplified filtration system will keep the water tanks and water lines cleaner and will minimize sediment in the water distribution loop.

Advantages: This process is a simple flow-through type with no preheat, addition of chemicals, chemical injection equipment. No special training is needed, other than the careful change out or cleaning of the filter elements. Capital costs are relatively low, about $10,000.

Disadvantages: Removal of color in water is not as nearly effective as multimedia filtration and coagulant. Cartridge filters incur a cost in their replacement. Costs can vary from $400 to $2000 per year, depending upon the frequency of filter changes.

A typical stainless steel filter housing is shown below in Figure 4.

Figure 4—Cartridge Water Filter Housing

Before installing a cartridge filtration system, a temporary system consisting of 3 each 20 in long polypropylene filter housings (Pentek “Big Blue” or equal), with pressure gauges upstream and downstream of each filter housing will be used to test the efficacy of the different filter elements. It is planned to put a 20 micron filter on the first housing, a 10 micron filter element on the second housing, and a 5 micron element on the third housing downstream. The Pump House Operator will record the pressures daily, so it will be known when each filter is loaded up, and a qualitative idea will be gained as to the usefulness of permanently adding a cartridge filter system to the design. This test would be done right after approval of this DAR, when a field trip is planned by the Engineer for addressing a demolition plan and a temporary operating plan for the existing pump house while the new one is being built.

Chlorination Issues

The well feeding Pump House 1 is considered true groundwater. However, to test this, the City of Chefornak has shut off the chlorine feed to Pump House 1 and is doing Bac-T tests on water in the pump house once a week for four more weeks to see if negative tests continue. The problem with chlorination is that dissolved organic carbon in the water will create disinfection byproducts, which, at certain levels can cause compliance problems for the City.

If people wanted to chlorinate water from the watering points in their own 5-gallon buckets, they would have to add 8 drops of household chlorine bleach in each bucket for 1 mg/l concentration, or 16 drops for 2 mg/l hypochlorite concentration.

The City cannot pre-chlorinate water for the watering points at the pump house because of the formation of disinfectant byproducts (DBP) that would exceed the maximum contaminant level (MCL). Lowering these levels would be too costly for the City. If individuals feel the need to chlorinate the water they get from the watering points, they are free to do so after they obtain their water.

6. Distribution System Water Use and Design Considerations

It is critical to have adequate water available in the existing water distribution system:

- The watering points require adequate water to operate so the public can obtain water for bathing and washing clothes;
- To maintain circulation in winter, and to prevent freezing of the water distribution, it is necessary to have water from the existing PHS well available to pump into the system;
- It is necessary to have an adequate flow of water to supply the school ultrafiltration/ reverse osmosis (UF/RO) water treatment system with adequate water to fill their potable water tanks without interruption. The school treatment system operates automatically 2 to 3 times per day, presently consuming 2500 gallons per day for their water treatment;
- It is necessary to have a continuous flow of water through the 3-in HDPE water loop piping of 20 to 35 gpm to keep enough heat in the 10,000 LF water loop.

An adequate amount of water in the 20 year design horizon will be 8,000 gallons per day, or an average of 5.6 gpm. This would consist of:

1,000 gallons per day for watering points;

1,000 gallons per day for Clinic;

3,000 gallons per day for school treatment system;

<u>3,000 gallons per day for Washeteria;</u>

8,000 gallons per day total.

7. Wastewater generation

Wastewater generation must be minimal in this facility. The only economical solution to the disposal of wastewater is to haul it away by the existing wastewater vacuum tank trailer or sled. This limitation on wastewater generated affects the choices of equipment in design. For example, a multimedia filter would be one option in the filtration of the well water, but backwash water would require a settling pond and a place to dispose of decanted waste water after the filter sludge is settled in this pond. There is no room for a settling pond on the property, and there is no place to drain out the clarified water, except for hauling it away in the City's vacuum tank trailer.

If a cartridge filtration system is used, then the only wastewater generated would be the contents of the filter housings.

To accommodate this wastewater, a 20 gallon wastewater tank would be available to store the filter canister wastewater. It can be pumped with transfer pump and garden hose to transit tank for disposal on a sled or trailer as required.

8. Drainage, Waste, and Vent piping requirements

Drainage, Waste, and Vent (DWV) piping will not be required, as there will be no wastewater piping.

9. Distribution System Piping Connections

The existing water distribution system for the watering points, school, Washeteria, clinic, or other load is an 8 in inner pipe duct x 15 in OD arctic pipe carrying two each 3 in SDR11 HDPE water pipes. These two water pipes form a circulating water loop that circulates heated water through the arctic pipe duct that keeps the distribution system warm. Connections to this water distribution piping at the building will be done through an insulated arctic box on the building, designed to allow for movement of the arctic pipe without undue stresses.

10. Heat loads and air requirements

The heating system in Pump House 1 will be a simple 2-pipe hydronic system, with the following heat loads and preliminary heat estimates for 65°F inside temperature and -50°F outside temperature:

• Heating building envelope using unit heaters:	10,100 BTU/hr
• Heating building make-up air for ventilation:	15,300 BTU/hr
	1 air change per hour;
• Providing heat for keeping old PHS well thawed;	3,600 BTU/hr
• Providing backup heat for water distribution loop;	150,000 BTU/hr
• Heating arctic entrance to building	2,000 BTU/hr
Total Estimated Worst Case Heat Load at -50°F outside temp:	185,000 BTU/hr

The heating boilers will be two ea 123,000 net BTU/hour input high efficiency oil-fired cast iron units, using a 50% propylene glycol/deionized water mixture of heat transfer fluid. It is important to not use local water in the mix, as it may be too high in total dissolved solids.

The intent of the heating system design is to minimize the amount of heat production required for Pump House 1 by utilizing waste heat from the City power plant to keep the water distribution loop heated to an average 50°F. If the water distribution loop is heated by recovered waste heat, then the maximum heat load at -50°F outside temperature would be about 31,000 BTU/hr.

The temperature differential between hydronic supply and return will be 20°F. One hydronic pump with backup will be required for the hydronic heating system. The pump will be a canned rotor type with internal variable speed control to provide a constant pressure head as loads come on and off the heating system.

All piping, boilers, and appurtenances will be well insulated to minimize standby losses, thus saving heat energy. Coils will be operated by thermal or motorized valves to put the heat where it is needed, and not wasted in standby losses.

Pump House 1 is a low occupancy building, so ventilation requirements will be minimal: 0.5 air changes per hour for unoccupied, and 1.0 air changes per hour for an occupied building (usually one operator for a limited time. This translates to 60 cfm for unoccupied and 116 cfm for an occupied building.

The oil storage tank will be a double-walled tank with a maximum storage volume of 500 gallons.

11. Ventilation and Air Makeup system

The ventilation and air make up system will consist of a motorized damper and arctic air intake hood, coupled with an exhaust fan, rated to 200 cfm with speed control, and a motorized damper in the exhaust duct with weatherproof exhaust hood.

12. Electrical

Electric power will come directly from the nearby City electrical distribution system. It will go through a 100 amp meter/main with a 100-amp circuit breaker on the outside of the building. See one-line diagram on Sheet E4.1 of the 35% Plan Set (Appendix A).

To minimize electrical power use in this high cost area, high efficiency motors will be used and run time minimized or run speeds reduced by variable speed drives where appropriate. Interior lighting will be accomplished using LED wraparound tube type with prismatic lenses. Outside lighting will consist of LED fixtures on photocells.

It may be required to install two taller poles in the vicinity of the lot containing the existing pump house to provide clearance for the power and telephone lines during times of heavy snow drifting.

13. Building Security

The proposed Pump House 1 will have only one door to the outside and no windows, so with a well built industrial door, access to the inside of the pump house will be difficult. Setting up a camera system with links back to the City Office will be expensive---in the order of $3000 or more, and the cost of a radio or dedicated telephone link will be in the order of $1200 per year. It may be better to do a motion detecting system with an outside alarm horn and light rather than a camera system. The motion detecting system and alarm should be approximately $2000 to $3000 installed. That amount will be capital costs, with no recurring O&M costs.

E. Existing Pump House 1 Well Field Design Criteria

The existing City well was drilled over 40 years ago and has been used for almost 30 years. It has been very stable over that time, with no evidence of frost jacking or other adverse effects.

1. Geotechnical

The well goes down over 90 feet deep in strata roughly described in Section III.B above.

2. Well Head

The well head will have to be extended to match the arctic box on Pump House 1 so that the arctic pipe connecting the well head to the arctic box on Pump House 1 will be level. Raising the well head will also make it less susceptible to snow drifting.

The exposed well pipe above the ground will be insulated with a piece of 6 in x 15 in arctic pipe slipped over the 4 in steel well casing. The well head box on the top of the well casing will be constructed of 1/8 in thick aluminum, with 4 in of extruded rigid Styrofoam insulation around all sides, bottom, and top of the box.

The well will have a sanitary seal on top, with a pitless adaptor on the side of the well for the drop pipe.

A method for hoisting out the well pump and HDPE drop pipe will be provided so that the well pump and drop can be hoisted out by hand or small electric winch.

3. Well Connection to Pump House 1

The well drop pipe will be connected to the side of the well casing inside the well with a 1-1/4 in pitless adaptor for easy connection to the HDPE pipe connecting the well to the Pump House. A 6 in HDPE by 12 in outside diameter (OD) arctic pipe will be used to connect the well head box to the arctic box on the outside of the Pump House. This arctic pipe will serve as a duct to house:

- The well water HDPE delivery pipe running to the Pump House;
- Hydronic heating loop to keep arctic pipe connection to well and upper part of well interior warm;
- Electric backup heat trace for emergency heat backup for arctic pipe well connection and well pipe thawing.

An electrical conduit outside the arctic pipe will house wiring for the well pump.

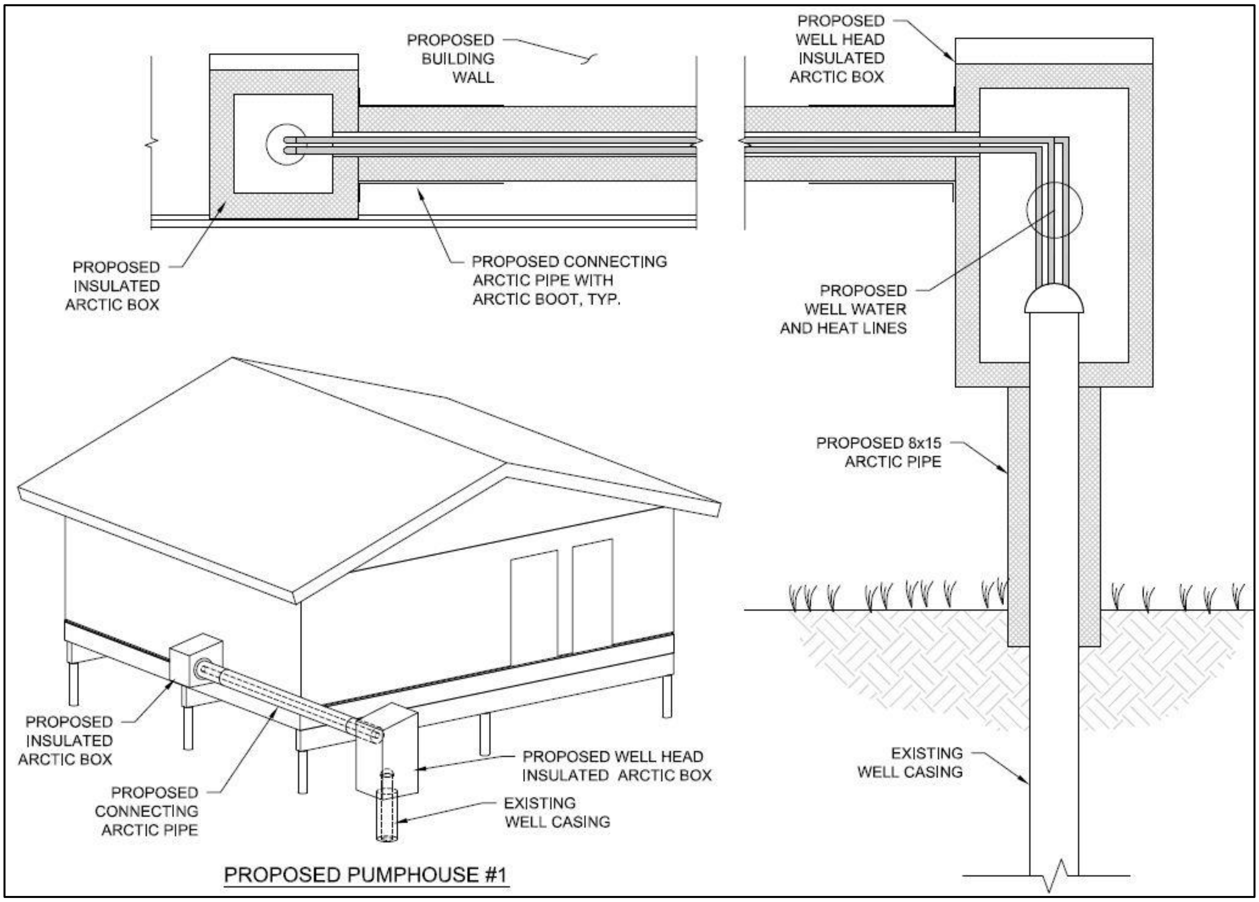
4. Well Line Heating

The well line as well as the upper part of the well interior will be heated with a ¾ in PEX hydronic heating loop, using water as the heating medium. Heating using oil-fired hydronic heat costs one-third of the cost of electric heat, so over a year, savings are substantial.

Backup electric self-limiting heat trace of 8 watts per foot will be provided to thaw out the well and connecting lines in an emergency.

A conceptual view of the well and connecting piping to the proposed Pump House 1 is shown on the next page in Figure 5.

Figure 5—Conceptual illustration of well connection to proposed Pump House 1



5. Water Treatment

The water supplied by the existing pump house for the last 30 years has been used for utility (bathing, steam baths, hand washing and laundry), and not for drinking. This has mainly been due to the fact that TDS levels are higher than the 500 mg/l allowed by drinking water standards.

Previous treatment consisted of a coagulant added upstream to two multimedia filters. In the process there was not enough reaction time to form floc, so the process was not very effective. In addition, the backwash water was dumped outside the building, so that the relatively warm backwash water contributed to warming up the soil around the east end of the pump house and caused serious settlement in the foundation and floor of the building.

The proposed water filtration system for this utility water will be two single pleated cartridge filters in series. The first unit will be a 10 or 20 micron filter and the second one will be a 10 or 5 micron filter, depending upon filter tests to be scheduled after this DAR is finished. The maximum flow rate through these filters will be 15 gpm from the well, so these filters will be very conservatively sized for loading. Each housing will hold one cartridge with 170 sf of filter area, as shown in Figure 4 on page 13.

6. Tank Fill and Draw

The two water storage tanks will be filled from the top. The line coming in from the well will split and feed each of the two tanks equally. One tank can be shut down by manually shutting off its tank fill valve.

Each tank will have a 2-in FIPT draw fitting with suction elbow inside the tank for connecting to the pressure pumps, or for draining down the tank during cleaning or other maintenance functions.

IV. Land Status/Site Control

A. Land Status

The site for the proposed replacement of the existing WTP is located on Lot 7, Block 2, Tract A, USS 4421). This lot was transferred over to the City of Chefornak in a Trustee Deed in Book 43, Page 274, March 27, 1986, in the Bethel Recording District of Alaska.

B. Site Control

The City of Chefornak owns the lot on where the existing Pump House sits, and where the replacement Pump House 1 will be located. Site control documents for this property, as described in section A above can be found in Appendix B.

V. Environmental Determinations and Permit Requirements

An Environmental Assessment is required for this Pump House 1 grant.

Archaeological clearance from the State Historic Preservation Office is required.

An approval to construct and operate will be required by Alaska Department of Environmental Conservation, Drinking Water Division, but not Wastewater Division.

An Approval to Construct will be required after plan review from the State of Alaska, Department of Public Safety, State Fire Marshal, Plan Review Bureau, Anchorage office.

VI. Cost Estimates

A. Conceptual Budget

1. Capital Costs

CHEFORNAK PUMP HOUSE 1 --- 35% CAPITAL COST ESTIMATE					
Line No.	**Cost Description**	**Unit Cost**	**Unit**	**Quantity**	**Extended Cost**
1	Pile Foundation	$ 5,750	EA	12	$ 69,000
2	Foundation Beams	$ 500	EA	3	$ 1,500
3	Building Shell	$ 164,300	Lot	1	$ 164,300
4	Mechanical	$ 52,500	Lot	1	$ 52,500
5	Electrical and Controls	$ 32,000	Lot	1	$ 32,000
6	Well Improvements	$ 25,000	Lot	1	$ 25,000
7	Labor	$ 3,000	Day	100	$ 300,000
8	Freight	$ 50,000	Lot	1	$ 50,000
9	Support	$ 15,000	Lot	1	$ 15,000
10				**SUBTOTAL**	**$ 709,300**
11	Engineering @10%				$ 70,930
12	Construction Management @16%				$ 113,488
13				**TOTAL**	**$ 893,718**

2. Operation and Maintenance (O&M) Costs

The follow O&M budget has been developed using values calculated from estimated performance of the plant, coupled with an estimated amount of City administrative tasks. Repair and replacement costs of equipment have been included. Capital replacement costs have not been included.

Expense Category	Annual Estimate	
Administration	$	7,000
Labor	$	10,800
Miscellaneous Materials	$	300
Electricity	$	3,960
Heating Fuel	$	4,200
Water Treatment	$	900
Sewage Treatment	$	-
Insurance	$	1,000
Repair and Replacement Account	$	4,025
Other	$	2,500
Capital Replacement Account	$	-
Total Annual Expenses	**$**	**34,685**

Administration		
Administrator	$	5,200
Clerk	$	1,000
Office Supplies	$	300
Postage	$	300
Occupancy Costs	$	200
Other		
Total Administration	**$**	**7,000**

Labor		
Operator I	$	5,200
Operator II	$	2,600
Training	$	3,000
Other	$	-
Other	$	-
Total Labor	**$**	**10,800**

Miscellaneous Materials		
Cleaning Supplies	$	300
Other	$	-
Other	$	-
Total Miscellaneous Materials	**$**	**300**

Electricity		
Electricity (6,000 kwh/yr)	$	3,960
$0.66/kwh	$	-
Total Electricity	**$**	**3,960**

Heating Fuel		
Fuel (600gal/yr, $7.00/gal)	$	4,200
Other	$	-
Total Fuel	$	4,200

Water or Water Treatment		
Chemicals	$	-
Testing	$	700
Postage/Freight	$	200
Filter elements	$	-
Total Water/Water Tmt	$	900

Sewer or Sewage Treatment		
Chemicals	$	-
Other		
Other		
Total Sewer/Sewer Tmt	$	-

Insurance		
Building Insurance	$	680
Liability Insurance	$	320
Other	$	-
Total Insurance	$	1,000

Other		
Vehicle Expense	$	1,500
Gasoline	$	1,000
	$	-
Total Other	$	2,500

O&M costs are those costs for the proposed Pump House 1 only, and do not include costs for watering points, water distribution loop costs, other than for pumping and water loop heating. It is assumed that the City power plant will provide water distribution loop heat from waste heat recovered from the City generators cooling system.

VII. Recommendations

1. The foundation for the building should be micropiles anchored to bedrock, for resistance to settlement and frost heave.
2. Because of space limitations on the lot where the City Pump House is located, the north half of the existing Pump House must be removed and internal piping and power must be relocated to the south half of the building during placement of the piles in March and April.
3. During early spring pile installation, a temporary Pump House structure will have to be erected and a temporary treatment train with hoses and cam-lock fittings made to keep water supplied to the village while construction of the new Pump House 1 is underway.
4. To be cost effective, all micropiles should be placed in the spring (March and April) for Pump House 1, Pump House 2, and the Washeteria to minimize mobilization and demobilization costs for each project (estimated 70 piles total).
5. The design should be completed and approved for construction by February 1, to meet material procurement for the summer barge. The pile foundation designs for Pump House 1, Pump House 2, and Washeteria should be completed by the end of this year for early bids right after New Years for March-April construction.
6. Pump House 1 building shell should be engineered wood joists for the floor, with SIP walls and engineered wood rafters for most rapid erection of the shell. Roofing and wall siding should be standard 3 ft wide ribbed roofing for ease of installation and maintenance.
7. Clearance under Pump House 1 should be a minimum of 4 ft to allow for wind to be unobstructed to the maximum extent to prevent snow drifting around building. If possible, metal wire perimeter fencing should be 4 inch square mesh to minimize obstruction to winds.
8. An adequate amount of shelving and cabinet space should be allowed for water testing and spare parts.

Appendix A

35% Plan Set

Appendix B

Trustee Deed for Pump House 1 lot, owned by the City of Chefornak

Appendix C

City Well water quality data and excerpts from, *Report: Chefornak Well Drilling and Development Project*, State of Alaska, Department of Natural Resources, Department of Mining and Water Management, March 3, 1995

Appendix D

Geotechnical Recommendations for Proposed Pumphouses, Chefornak Alaska

Golder & Associates, November 20, 2014